

**WHAT IS CLAIMED IS:**

1       1. A method for monitoring transmissions over a unidirectional optical fiber loop  
2 coupling multiple nodes, characterized by:  
3       measuring a round trip delay time for a signal sent from a first node to travel around the  
4 unidirectional optical fiber loop and be received at the first node, and  
5       using the measured round trip delay time to account for temperature induced affects on  
6 signal transmissions over the unidirectional optical fiber loop.

7  
8       2. The method in claim 1, further comprising:  
9       measuring a first round trip delay time;  
10       subsequently measuring a second round trip delay time;  
11       determining a temperature-induced delay time correction based on the first and second  
12 round trip delay times; and  
13       determining a time difference between the first node and one or more other nodes  
14 coupled to the unidirectional optical fiber loop based on the determined temperature-induced  
15 delay time correction.

16  
17       3. The method in claim 2, further comprising:  
18       time synchronizing the multiple nodes taking into account the determined temperature-  
19 induced delay time correction.

20  
21       4. The method in claim 3, wherein a time difference between the synchronized  
22 nodes is in the range of one nanosecond to several microseconds.

23  
24       5. The method in claim 2, wherein adjacent nodes in the unidirectional optical  
25 fiber loop are coupled together by an optical fiber link, further comprising:  
26       determining a link time delay associated with one or more of the links, and  
27       using one or more determined link time delays in determining one or more time  
28 difference between the first node and the one or more other nodes.

30        6.    The method in claim 5, wherein optical time domain reflectometry is used in  
31 determining the time delay associated with each link.

32  
33        7.    The method in claim 5, wherein the temperature-induced delay time correction  
34 is based on a difference between the first and second round trip delay times and the one or  
35 more determined link time delays.

36  
37        8.    The method in claim 5, further comprising:  
38            generating a time synchronization message based on the temperature-induced delay  
39 time correction, and

40            sending the time synchronization message from the first node to a second of the nodes  
41 to permit the second node to adjust the absolute time at the second node to be synchronized  
42 with the absolute time at the first node.

43  
44        9.    The method in claim 5, further comprising:  
45            sending a timestamp message from one or more of the other nodes to the first node  
46 indicating a local time at that other node, and  
47            determining a respective local time difference between the time in each received  
48 timestamp message and the local time at the first node.

49  
50        10.   The method in claim 1, wherein the first node is a main base station unit,  
51 including processing circuitry and a central clock source, and the one or more other nodes are  
52 remote base station units including radio transceiving circuitry for communicating over a radio  
53 interface with a mobile radio terminal,  
54            wherein the mobile terminal determines one or more a round trip times (RTTs), the  
55 RTT corresponding to the time for an RTT message transmitted by the mobile terminal to  
56 travel to the remote base station unit and be returned from the remote base station unit to the  
57 mobile terminal, and  
58            wherein the mobile terminal calculates the one or more RTTs using the measured round  
59 trip delay time.

60  
61        11.   The method in claim 10, further comprising:

62           the mobile terminal sending an RTT message to one of the remote base station units  
63   over the radio interface;  
64           the one remote base station unit sending the RTT message to the main base station unit  
65   via the unidirectional optical fiber loop;  
66           the main base station unit modifying the RTT message with a recently determined  
67   round trip delay time that accounts for temperature induced delay variations in the loop;  
68           the main base station unit sending the modified RTT message to the remote base station  
69   unit via the unidirectional optical fiber loop;  
70           the remote base station unit transmitting the modified RTT message to the mobile  
71   terminal over the radio interface; and  
72           the mobile terminal determining the RTT based on the modified RTT message.

73

74           12.    The method in claim 1, wherein one or more links of the unidirectional fiber  
75   loop are subjected to temperature variations greater than those to which one or more other  
76   portions of the unidirectional fiber loop are subjected.

77

78           13.    The method in claim 1, further comprising:  
79           calculating a temperature-induced delay time correction for one or more of the nodes  
80   other than the first node.

81

82           14.    Apparatus for use in monitoring transmissions over a unidirectional optical fiber  
83   loop coupling multiple nodes, characterized by electronic circuitry configured to:  
84           measure a round trip delay time for a signal sent from a first node to travel around the  
85   unidirectional optical fiber loop and be received at the first node, and  
86           account for temperature induced affects on signal transmissions over the unidirectional  
87   optical fiber loop using the measured round trip delay time.

88

89           15.    The apparatus in claim 14, wherein the electronic circuitry is located in a first  
90   one of the nodes associated with a central system clock and is further configured to:  
91           determine a first round trip delay time;  
92           subsequently determine a second round trip delay time;  
93           determine a temperature-induced delay time correction based on the first and second  
94   round trip delay times; and

95       determine a time difference between the first node and one or more other nodes coupled  
96    to the unidirectional optical fiber loop based on the determined temperature-induced delay time  
97    correction.

98

99       16.    The apparatus in claim 15, wherein the electronic circuitry is further configured  
100    to time synchronize the multiple nodes taking into account the determined temperature-induced  
101    delay time correction.

102

103       17.    The apparatus in claim 16, wherein a time difference between the synchronized  
104    first and second nodes is in the range of one nanosecond to several microseconds.

105

106       18.    The apparatus in claim 15, wherein adjacent nodes in the unidirectional optical  
107    fiber loop are coupled together by an optical fiber link, further comprising:

108           means for determining a link time delay associated with one or more of the links,  
109           wherein the electronic circuitry is further configured to use one or more determined  
110    link time delays in determining the time difference between the first node and one or more  
111    other nodes.

112

113       19.    The apparatus in claim 18, wherein means for determining uses optical time  
114    domain reflectometry in determining the time delay associated with each link.

115

116       20.    The apparatus in claim 18, wherein the temperature-induced delay time  
117    correction is based on a difference between the first and second round trip delay times and the  
118    one or more determined link time delays.

119

120       21.    The apparatus in claim 18, wherein the electronic circuitry is further configured  
121    to:

122           generate a time synchronization message based on the temperature-induced delay time  
123    correction, and

124           send the time synchronization message from the first node to a second of the nodes to  
125    permit the second node to adjust the absolute time at the second node to be synchronized with  
126    the absolute time at the first node.

127

128        22. The apparatus in claim 18, wherein one or more of the other nodes is configured  
129 to send a timestamp message to the first node indicating a local time at that other node, and  
130        wherein the electronic circuitry is further configured to:  
131            determine a respective local time difference between the time in each received  
132 timestamp message and the local time at the first node.

133

134        23. A system using the apparatus in claim 14, wherein the first node is a main base  
135 station unit and the one or more other nodes are remote base station units including radio  
136 transceiving circuitry for communicating over a radio interface with a mobile radio terminal,  
137        wherein the mobile terminal is configured to determine one or more a round trip times  
138 (RTTs), the RTT corresponding to the time for an RTT message transmitted by the mobile  
139 terminal to travel to the remote base station unit and be returned from the remote base station  
140 unit to the mobile terminal, and

141            wherein the mobile terminal is configured to calculate one or more RTTs using the  
142 determined round trip delay time.

143

144        24. A system using the apparatus in claim 23, wherein:  
145            the mobile terminal is configured to send an RTT message to one of the remote base  
146 station units over the radio interface;  
147            the one remote base station unit is configured to send the RTT message to the main  
148 base station unit via the unidirectional optical fiber loop;  
149            the main base station unit is configured to modify the RTT message with a recently  
150 determined round trip delay time that accounts for temperature induced delay variations in the  
151 loop;  
152            the main base station unit is configured to send the modified RTT message to the  
153 remote base station unit via the unidirectional optical fiber loop;  
154            the remote base station unit is configured to transmit the modified RTT message to the  
155 mobile terminal over the radio interface; and  
156            the mobile terminal is configured to determine the RTT based on the modified RTT  
157 message.

159        25. The apparatus in claim 14, wherein one or more links of the unidirectional fiber  
160      loop are subjected to temperature variations greater than those to which one or more other  
161      portions of the unidirectional fiber loop are subjected.

162        26. The apparatus in claim 14, wherein the electronic circuitry is further configured  
163      to calculate a temperature-induced delay time correction for one or more of the nodes other  
164      than the first node.

166